Experimental Studies of Wetting Transitions

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When a liquid droplet is put onto a surface, two situations distinguishable by the contact angle may result. If the contact angle is zero, the droplet spreads across the surface, a situation referred to as complete wetting. Second, if the contact angle is between zero and 180°, the droplet does not spread, a situation called partial wetting. A wetting transition is a surface phase transition from partial wetting to complete wetting.

The wetting transition is generally first-order (discontinuous). At the wetting transition, a discontinuous jump in film thickness occurs from a molecularly thin to a thick film. We show that the first-order nature of the transition can lead to the observation of metastable surface states and an accompanying hysteresis.

The second part of the talk deals with the exceptions to the first-order nature of the wetting transition. We have reported two different types of continuous or critical wetting transitions, for which a discontinuity in a higher derivative of the surface free energy occurs. This leads to a continuous divergence of the film thickness. The first type is long-range critical wetting, due to the long-range van der Waals forces. We show that this transition is preceded by the usual first-order wetting transition, which however is not achieved completely.

The second type of continuous transition is short-range critical wetting, for which the layer thickness diverges continuously all the way from a microscopic to a macroscopically thick film. This transition is interesting, as renormalization-group studies predict non-universal behavior for the critical exponents characterizing the wetting transition.